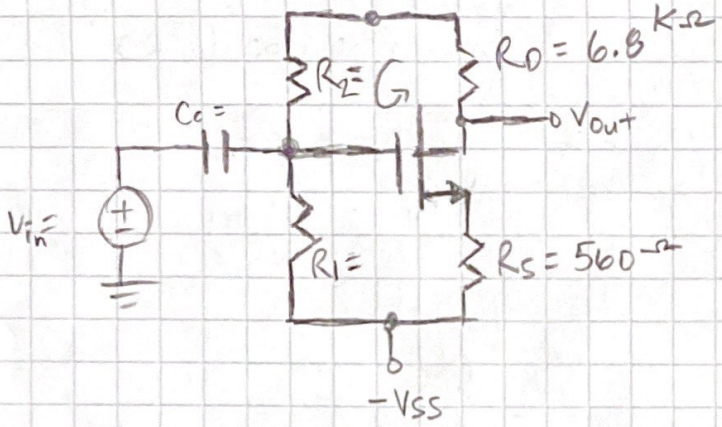
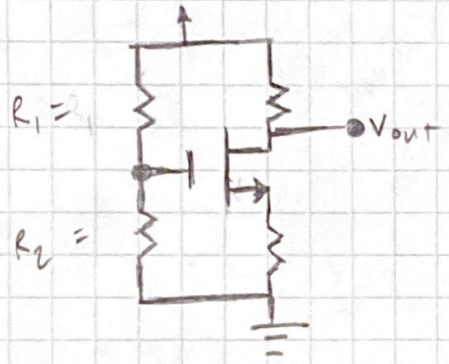
Hand Calculations ECE 322L - Lab 3 12-Feb 2020

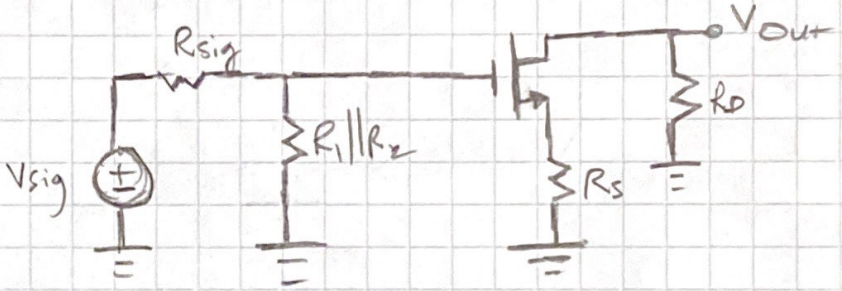


CS w/ source resistor

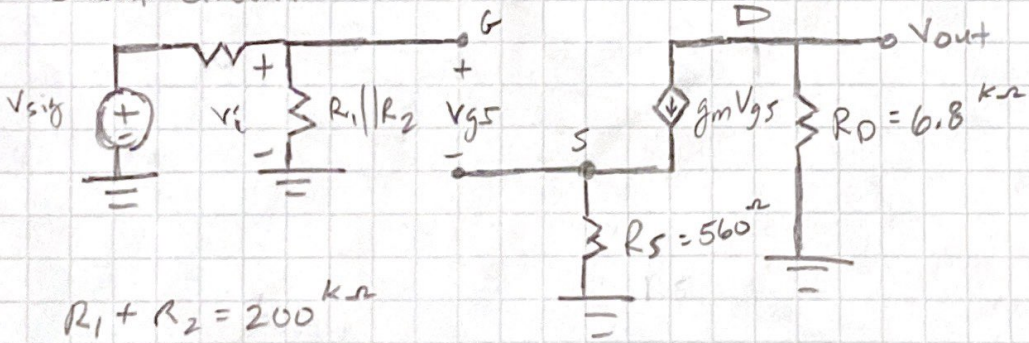
DC



AC



Small circuit



$R_1 + R_2 = 200^{k\Omega}$

$R_{in} = R_1 || R_2$

$A_{vout} = A_v$

$V_{in} = \frac{I_{in}}{R_1 || R_2}$

$V_{out} = -i_{R_D} \cdot R_D$

$= -\frac{R_D}{R_S} \cdot V_S$

$i_{R_D} = i_{R_S} = \frac{V_S}{R_S}$

$V_S = V_{in} - V_{gs}$

$V_{gs} = V_{in} - V_S$

$i_{R_S} - g_m V_{gs} = 0 \rightarrow \frac{V_S}{R_S} - g_m(V_{in} - V_S) = 0$

$$\frac{V_s}{R_s} - g_m(V_{in} - V_s) = 0 \rightarrow \frac{V_s}{R_s} - g_m V_{in} + g_m V_s = 0$$

$$V_s\left(\frac{1}{R_s} + g_m\right) = g_m V_{in} \rightarrow V_s = \frac{g_m V_{in}}{\left(\frac{1}{R_s} + g_m\right)}$$

$$V_{out} = -\frac{R_D}{R_s} \cdot V_s \rightarrow V_{out} = -\frac{R_D}{R_s}\left(\frac{g_m V_{in}}{\left(\frac{1}{R_s} + g_m\right)}\right)$$

$$A_{V_0} = \frac{V_{out}}{V_{in}} = -\frac{g_m R_D}{1 + g_m R_s}$$

$$= -6.964$$

$$g_m = 2\sqrt{K_n I_D}$$

$$= 2.4015 \times 10^{-3}$$

$$V_{in} = \frac{V_s\left(\frac{1}{R_s} + g_m\right)}{g_m}$$

2N7000 → Resistmce

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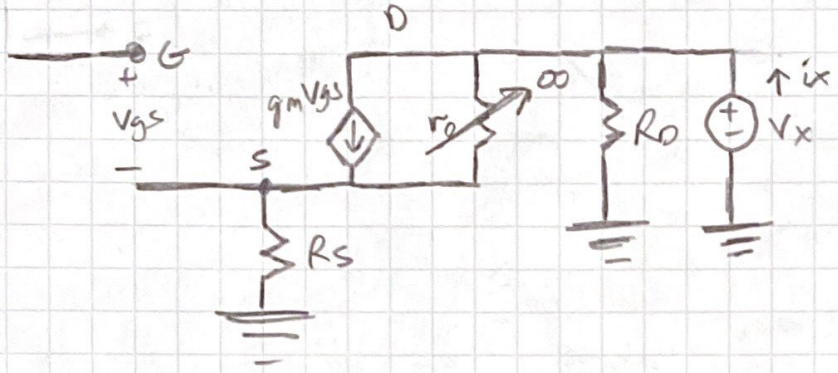
Set $V_{sig} = 0$, attach V_x and calc i_x



$$I_D = \frac{1}{2} K_n' \left(\frac{W}{L}\right)_n (V_{gs} - V_{TN})^2$$

$$V_G = V_{DD} = 12^V$$

$$790^{\mu A} = 1.825^{mA/V} \frac{1}{2}(V_{gs} - 1)^2 \rightarrow V_{gs} = \begin{cases} 1.9305^V \\ 0.06954^V \end{cases}$$

$$V_S = V_G - V_{GS} = \qquad V_G = \frac{R_2}{R_1 + R_2} V_{in}$$

LAB 3 HAND CALCS

$R_1 + R_2 = 200^{k\Omega}$ $\quad R_{in} = R_1 + R_2 \quad i_{in} = \frac{V_{in}}{R_{in}} = \frac{V_{in}}{R_1 + R_2}$

$$I_D = \frac{1}{2} k_n' \left(\frac{W}{L}\right)_n (V_{GS} - V_{TN})^2$$

$$790^{\mu A} = \frac{1}{2}\left(1.625^{mA/V^2}\right)(V_{GS} - 1)^2 \rightarrow V_{GS} = 1.9305^{V}$$

$V_G = V_S + V_{GS}$

$V_G = 0.4424^{V} + 1.9305^{V} = 2.3729^{V}$

$i_D = i_S = \frac{V_S}{R_S}$

$V_S = i_D R_S = (790^{\mu A})(560^{\Omega})$

$= 0.4424^{V}$

$V_G = \frac{R_2}{R_1 + R_2} V_{DD} \rightarrow \frac{V_G}{V_{DD}} = \frac{200^{k\Omega} - R_1}{R_1 + (200^{k\Omega} - R_1)} =$

$V_{DD} - V_D =$

$R_2 = 160.45^{k\Omega}$ $\quad R_1 = 39.548^{k\Omega}$

$\frac{V_{DD} - V_D}{R_3} = I_D$

$V_D =$

$I_D R_3 = V_{DD} - V_D$

$V_D = V_{DD} - I_D R_3 = 6.628$

$-g_m V_{gs} (R_4)$